Focusing and Discourse*

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In a discourse, speakers center their attention on a particular element of the discourse, and they talk about it over one or more sentences of the discourse. This element is called the focus, and the process by which speakers center is focusing. Focusing is a cognitive process which is active during the interpretation of discourse rather than during the interpretation of isolated sentences. To help the hearer determine how successive sentences are related, the speaker uses anaphora to signal the same focus rather than re-introducing in each sentence a noun phrase describing the element of discourse under discussion. This paper describes a process model of focusing that specifies what syntactic, semantic, and world knowledge constraints are needed for the hearer to track the speaker's focus in a discourse. The paper illustrates that focusing is a well constrained behavior for speakers, and argues that focusing is a necessary condition for maintaining Grice's maxim of conversation.

I. THE FOCUS OF DISCOURSE

One of the basic units of language communication is a discourse. Informally and intuitively, a discourse may be defined as a connected piece of text or spoken language of more than one sentence spoken by one or more speakers. If there are several speakers, it must be assumed that they are trying to communicate with one another and are not all talking at once. If such an informal definition is to be helpful at all, some notion of what it means to be "connected" is needed. There are several different properties which can be ascribed to discourse connectedness. First, the participants must use the same language, or a language understood by all participants; second, the participants must carry out their discussion within some time-space interval; and third, the speaker or speakers must have some purpose in communicating—they are trying to talk about something. The something may be a person, an object, an event, or an act to be performed by the hearer. For the moment, I will assume only one thing at a time is talked about.

All of these properties make a set of sentences, spoken or written, connected into a discourse. In the remainder of this paper the first two properties will be held fixed, and the thing being talked about will be considered further.

In a discourse, speakers talk about something which is of interest to them. They center their attention on a particular element, and they talk about it for several sentences of their discourses. In recent literature, the element has sometimes been called a "topic" while at other times people are said to be "focusing" their attention on some element of the discourse. Using the latter terminology, I will speak both of the element which is the center of attention, that is, the element which is talked about as the *focus* of the discourse, and the process of centering attention, *focusing*.

Focusing is a cognitive process which is active during the interpretation of discourse rather than during the interpretation of isolated sentences. In general, a single sentence is insufficient to capture all the information that a speaker wishes to tell a hearer. One might expect that when a speaker uses several sentences, the object of discussion (the focus) would need to be reintroduced in each sentence. However, reintroduction is a highly redundant process, hence one would expect it to be inefficient. Furthermore, when spreading information over several sentences, the human speaker does not tightly relate all the sentences s/he speaks about a particular object. If reintroduction is not used, and hearers still claim to know what is being talked about, there must be some means by which the sentences are related to what the speaker wants to talk about.

In fact, the speaker uses two different means. First, the speaker uses special words which indicate to the hearer "that I am still talking about the thing I talked about in the previous sentence." Traditionally these signals are called anaphoric expressions or anaphora. Second, the speaker relies on assumed shared knowledge; s/he assumes that some connections between the focus and some other discourse elements are so common that one need not explicitly state what they are. Of course, there is a risk that the connections may no longer be obvious. Without these connections, the speaker's communication purpose may be lost, as the hearer may be unable to construct the relations between the focus and other entities under discussion, or may fail to understand the speaker's communication purpose.

Once we acknowledge the presence of a focus in discourse, then we must ask "how is that focus used?" How does a speaker choose one, and how does a hearer determine the speaker's choice? What aspects of discourse does a focus make easier to understand and why? Since speakers talk about more than one thing as a discourse progresses, how does the focus move around in the discourse as the speaker changes his/her center of attention?

A productive way of answering these questions depends on a process model of behavior which I will call the focusing process. The process behavior (a) indicates those expressions the speaker may choose from to signal the focus, (b) defines a sequence of discourse events which occur when a speaker focuses on

some element in the discourse, (c) enumerates the conditions for event sequences which result in understandable discourse, and (d) itemizes the information which the focusing process uses during each event. The model may be used to clarify both the hearer's understanding of the use of focus and the speaker's choices in using the focus, although this paper will concentrate on the hearer's understanding of focus use. The behavior of the process, and especially the specification of the allowable sequences of discourse with focusing, offer a descriptive model of a part of language behavior, namely the use of anaphoric expressions in discourse. To the extent that the description reflects constraints on possible behavior, it helps to explain why certain uses of anaphora are acceptable to native English hearers and why others are not.

The process model is founded on the two means of maintaining connectedness, that is, on the choices for anaphora and on the associations among objects in the world which are commonly known to speakers and hearers. Associative memory and rules for anaphora are described in Sidner (1979). This paper will develop the following basic themes:

1. Focusing is one criterion for defining how a text or a collection of spoken utterances is a discourse. Others include tensing information, story lines, and speaker's intended requests of the hearer.
2. The focus of the discourse, that is, what the speaker is talking about, can be tracked by a process model which, in addition to obeying syntactic and semantic constraints of language, indicates how referring expressions are used. These indications are used to update the focus according to the form and sequence of the expressions.
3. Focusing in discourse is a well constrained behavior. For example, speakers must mention things to focus on them, they are not free to jump about in the discourse without paying attention to what they have mentioned, and they must consider the effect of syntax and semantics on the kind of referring expressions used.
4. Focusing reflects Grice's (1975) maxim of conversation, namely it is the minimal condition for maintaining relevance in conversation. There are presumably additional conditions, but focusing is a necessary condition without which others are unsatisfactory.

In the discussion below, I will assume that there are cognitive representations of real world (and imaginary) entities, and I will use the term "discourse elements" to refer to those representations. In general, people use anaphora to refer to entities in the world, and the discussion in this paper argues that they focus on certain entities during a discourse as part of using anaphora. But in order to talk about that behavior as a process, I will speak of people as focusing on the cognitive representation corresponding to the real world or imaginary entity. In doing so, I am not assuming that people talk about the discourse elements, since

it is certain that people talk about things in the world other than discourse elements. While it might be simpler to exclude the discourse elements and representations altogether, I will show that these concepts help to provide an explanation of focusing as a human discourse behavior.

2. AN EXAMPLE OF FOCUSING

First let us examine some discourses and see how a speaker uses a focus. I will consider the use from the hearer's point of view, that is, from the view of how to comprehend the focus choices reflecting what the speaker is talking about. The first discourse is a monologue, in the form of a simple story.

D1–1 Last week there were some nice strawberries in the refrigerator.
 2 They came from our food coop and were unusually fresh.
 3 I went to use them for dinner,
 4 but someone had eaten them all.
 5 Later I discovered it was Mark who had eaten them.
 6 He has a hollow leg,
 7 and it's impossible to keep food around
 8 when his stomach needs filling.

In D1, three entities are mentioned in the first sentence. Only one of these, strawberries, is rementioned in the next sentence, and it is mentioned with an anaphor. The second sentence also introduces another new entity, the speaker's food coop, but sentence 3 rementions only the strawberries. In D1–3 the speaker also mentions a dinner and her/himself using "I". D1–4 rementions the strawberries and mentions for the first time a person referred to as "someone". D1–5 uses a cleft construction to name the someone while at the same time introduces a new element for discussion. The strawberries are once again rementioned, along with the speaker. D1–6 takes an interesting new turn. The strawberries are no longer mentioned and instead Mark is rementioned as "he" and then by the pronoun "his" in D1–8. Thus by the end of the discourse, the speaker has moved the discussion from the strawberries in the refrigerator to Mark, a strawberry eater.

A second sample discourse shows a simple interaction between two speakers who each contribute some comments to the conversation.

D2–1 B: How do you teach your students to use a calculator?
 2 A: I think students should use a calculator for a while.
 3 I give them problems to solve with it.
 4 and when they have trouble,
 5 I answer their questions about the problems.
 6 B: That's all well and good,
 7 but I think they need more instruction on the device to reduce the number of questions.

8 Instead I give them instructions,
9 and they use these to solve problems.
10 They don't have much trouble learning to use the machine.

In this discourse, A mentions and focuses on A's students and the calculator. The students are the actors using the calculator. A also mentions problems given to the students and then rementions the problems with a simple definite noun phrase.[1] B also rementions students with a pronoun and rementions the calculator by means of special language form called a lexical generalization; a "device" is a more general lexical form for a calculator. In the discourse "the device" takes the place of using "it" to remention the calculator since "it" is not a good choice for the speaker, although from the hearer's point of view it may be possible to recognize the link between calculator and "it." The reasons for this will be considered later. B introduces instructions into the discourse and then rementions them with the demonstrative pronoun "these." B concludes the discussion by rementioning the students once more with a pronoun and rementioning the calculator with another lexical generalization, machine.

Both D1 and D2 exemplify the first theme of this paper, namely that focusing keeps a discourse connected. Anaphoric expressions serve as syntactic signals of connectedness in discourse. By using these signals, the speaker indicates ways that one sentence of the discourse is connected to the previous sentences. The entities in focus, both the actor focus[2] and the discourse focus, are introduced with a full noun phrase and then either pronominalized or lexically generalized. Either way of rementioning the entities in focus indicates that they are still under discussion as the discourse progresses. When they are no longer relevant, the speaker does not explicitly drop them; instead new entities are introduced, and the speaker indicates a shift to the new focus using anaphoric expressions which relate to those new entities.

The use of anaphora to mark the focus of discussion reduces redundancy in the discourse. If the various kinds of anaphora were removed from English, D2 would look something like the revised version given below. In order to show the connection to the previous mention of an element of the discourse, each expression which was the same as a previous one would require a long definite noun phrase with a relative clause. That is, to produce the same connectedness as in D2, the variation below contains many more descriptive phrases.

D3-1 B: How do you teach your students to use a calculator?
2 A: I think students should use a calculator for a while.

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[1] A simple definite noun phrase is a definite noun phrase consisting only of a definite article and a head noun.

[2] In discourse processing both objects and animate agents can be in focus at any given time. Hence there can be both a discourse focus on the main object of discussion and an actor focus on animate agents. The actor focus reflects the speaker's attention on an animate agent acting in some way which is related to the discourse focus through verb phrases.

3 I give students problems to solve with the calculator.

4 and when the students to whom I gave problems to solve have trouble,

5 I answer each student's questions about the problems which I gave to students who solve problems to solve on the calculator.

6 B: That's all well and good,

7 but I think the students who I have given problems need more instruction on the calculator which students use, to reduce the number of questions which students ask.

8 Instead I give the students who I have given problems instructions,

9 and the students who I have given problems use the instructions I give to solve problems which I give students.

10 The students who I have given the problems don't have much trouble learning to use the calculator.

Not only is the above dialogue more cumbersome, but it also obscures the distinction between the particular calculator a student uses and calculators in general. If this distinction were made clearer, the length of some noun phrases would be even greater.

When the speaker uses anaphoric expressions to indicate discourse connectedness, s/he also highlights what is of concern over the whole discourse. When an entity in focus is rementioned anaphorically, the hearer also knows that the element of the discourse corresponding to that entity plays a more central role in the discourse. In effect, the anaphor signals that for some part of the discourse, it is that discourse element which deserves prolonged attention as part of the speaker's communication goals.

Without the anaphor to signal interest, the hearer has little means of determining the speaker's interest. For example, in D3 most of the entities in focus are rementioned with long noun phrases, but since long noun phrases can also be used when describing complex objects, length is not a measure of what the speaker considers central to the discourse. Anaphora can be used to mark the speaker's interest because the entities have been mentioned before and a briefer form can be used without confusion. One question must be asked; how does the speaker tell the hearer that certain discourse entities are ones which the speaker wants to continue talking about? In other words, how does the speaker signal a focus so that s/he may use anaphoric expressions unambiguously to remention that focus? This question will be answered in the next section, but first a brief diversion is needed to define what is meant by "rementioning" entities and their corresponding discourse elements with anaphoric expressions.

Often in a discourse people speak of expressions denoting some object or entity in the real world. Anaphoric expressions are taken to "refer back" to what the first expression denoted. However, in some cases, the first expression used in a discourse does not denote, although an anaphoric expression may still be used to "refer back" in some way to the first expression. What is the nature of the

anaphoric relation in this latter case? The anaphor may actually be used to refer[3] to something, and the first expression helps the hearer decide what that entity is. Thus, if someone is told,

> D4–1 Hernando bought some cookies at the store.
> 2 The cookies were rotten,
> 3 and he didn't want them,
> 4 so he asked the salesman for his money back.

the hearer knows what "the cookies" is intended to refer to even though the first expression, "some cookies" in the context of D4–4, does not denote a particular object from the hearer's viewpoint. Traditional approaches to anaphoric expressions defined the *antecedent* of an anaphoric term, or anaphor, as the words which the anaphor pointed back to in the discourse. This definition is inadequate because more than the words the speaker and hearer use are needed to study the cognitive behavior of language users. Hence, we need to consider the interpretation of the words in the discourse. I will define a relation of *specification* between a phrase such as "some cookies", along with its syntactic and semantic interpretation, and a structure in memory which represents the cookies for a hearer. That is, the speaker uses a phrase to specify a structure in his/her own memory which represents the cookies, and similarly, the hearer makes use of the phrase to specify a representation in her/his mind. Specification is the relation between the phrase, in addition to its syntactic and semantic representation, and the memory element. Often I will speak of a phrase as specifying a memory element without explicitly mentioning the syntactic and semantic interpretation associated with the phrase. The relation is depicted in Figure 1.

In the particular case of "some cookies", the memory structure is constructed during the comprehension process. The expression "the cookies" also specifies a memory element, and this element is the one specified by "some cookies". In other words, with the first phrase the speaker introduces some cookies that Hernando bought, while with the second, s/he says something about those particular cookies. Thus, the definite noun phrase use in D4 is a *cospecification*. The noun phrase and its interpretation cospecifies with the phrase "some cookies" and its interpretation to the memory element depicted in Figure 1. By describing memory representations and specifications, we are not committing ourselves to the real world existence of entities denoted by the representations—a philosophic position of problematic nature. Instead, we are committed to the idea that the speaker uses a noun phrase to create an element in a person's mind (or by analogy in a computer database) which may be used in talking about the entity which the mental element represents.

Of course, the memory may have structures which exist before anything is said. If I begin talking about Jimmy Carter, I will use (as will any normal U.S.

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[3]For discussion of the philosophical matters of referring pronouns, see Evans (1977).
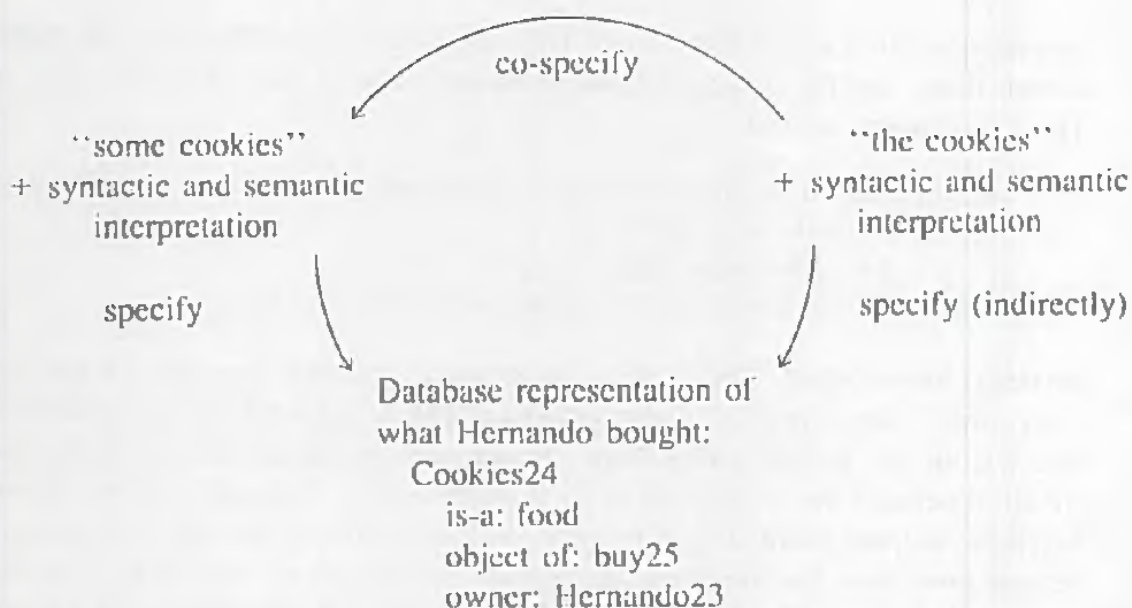
FIG. 1.   Interpretation of an indefinite description relation is depicted in Figure 1.

reader) a preexisting representation which tells me that I associate certain proper-
ties with the name of Jimmy Carter; as a speaker, I assume this about my hearers
as well. When hearers and speakers establish the cospecifiers of anaphora, they
choose a memory element which represents what the speaker is talking about. In
the rest of this paper, the cospecifier of an anaphoric phrase is that noun phrase
plus syntactic and semantic interpretation which specifies the same memory
element that the speaker intends the anaphor to specify. The anaphor and its
interpretation is said to cospecify with the noun phrase and its interpretation to
the memory element. As with specification, I will speak less formally of phrases
cospecifying with other phrases and assume that the interpretation of the phrases
is implicit in the terminology. Finally, "discourse elements" are just those
memory elements which become specified during a discourse.

3. TRACKING THE DISCOURSE FOCUS: A PROCESS MODEL

The process of focusing can be described as tracking the speaker's focus from the
hearer's point of view, or alternatively, as setting the focus from the speaker's
point of view. The first view will be considered here. A hearer does not have
privileged information about what is in a particular speaker's head, so the hearer
must decide what the speaker is talking about on the basis of what the speaker
uses as initial referring expressions and subsequent cospecifying anaphoric ex-
pressions. The hearer follows the focus and checks to see if the anaphoric
expressions which the speaker uses cospecify with the hearer's representation of
the focus. The hearer is tracking the speaker's focus because s/he can determine
what is being talked about only after the speaker has said something.

The process model of focusing and focus tracking which will be considered in this paper has three parts. First, the hearer, modelled as an information process, chooses a focus based on what the speaker initially says. Then the hearer uses this focus to interpret the anaphoric expressions in the discourse. The hearer must keep in mind whatever other newly mentioned elements the speaker has introduced, since sometimes an anaphor may cospecify with one of these instead of with the element in focus. Finally, the hearer updates the focus using interpretations of anaphora which result from the previous interpretation step. During this last phase, if the hearer has decided that an anaphor cospecified with something other than the focus, and the focus was not mentioned, the hearer will decide that the focus has shifted to a new element of the discourse. If we view the three steps the hearer goes through as processors instead of as an actual human hearer, then the above description sketches a simple process model of focus tracking.

So far, the process model looks circular. A focus is chosen, it is used to determine how an anaphor cospecifies with the focus, and then the cospecification is used to determine the focus. In fact, the model is not circular, but its steps are cyclic. The processor cycles through these three steps for each sentence in the discourse. The cycling machine differs from logical circularity because the cycling depends on new information presented over time, that is, the time of each sentence of the discourse. For example, reconsider the first few sentences of D1. The hearer decides that the speaker is talking about the strawberries in the refrigerator. In the next sentence the anaphor "they" cospecifies with the focus; the "our" cospecifies with a group of which the speaker (as actor focus) is a member. Once D1-2 is fully interpreted, the third phase process for focus tracking looks to see how the anaphora have been used and decides that the discourse focus is unchanged from D1-1. To interpret D1-3, the focusing process cycles through all three steps again.

Now let us consider the steps in more detail. Step 1 is called choosing a focus. The choice of a focus depends on several phenomena. One of these is syntax: there are constructions which mark focus, such as there-insertion sentences illustrated in s1.

s1 There once was a wise old king who lived on a mountain.

Another phenomenon which marks focus is speech stress and prosodics: it appears that these mark what the speaker is most interested in talking about. In s2, if contrastive stress is put on Jeremy, the hearer might expect that the next sentence will say more about him.

s2 I want one of JEREMY'S pictures.

Another phenomenon is case analysis: certain cases of the verb appear preferred as the place to indicate what is going to be talked about; in s3 the focus of the discussion is likely to be the speaker's turtle.

s3 I got a really pretty turtle this week.

Fourth, certain determiners like "this" and "that" are indicators of what is of interest and of what is currently not in focus respectively, as in s4.

s4 I talked with this lady in the credit department, but she didn't give me much help with my order.

Finally, a fifth phenomenon is knowledge associations. If someone is talking about a clock and then says,

s5 The dial isn't very well lighted.

the focus of discussion is still about that clock. It is the use of the focus mechanism and the focused element which tie all these different phenomena into one mechanism.

When no other phenomena apply, the default choice for selecting a focus is to rely on the semantic object, that is, the element which is usually called the direct object for a verb, but which is buried in a prepositional phrase for some verbs; for example, in the sentences below there is no direct object but the semantic object is clear.

s6 Pick up the big red block.
s7 Please focus on the star of India in the case on the left.

Usually this object is called the object case (Fillmore, 1968) or the theme (Gruber, 1976).

The next step in the processing is anaphora interpretation. In this phase two kinds of anaphora are interpreted: personal pronouns and definite noun phrase anaphora, that is, those noun phrases which contain one of the articles "the," "this," or "that." Rather than state all the rules for interpretation, I will describe the general form of the processor for this phase. The rules are presented in detail in Sidner (1979, 1981). Given an anaphor, the processor acting as an interpreter must decide whether the anaphor cospecifies with the current discourse focus, with an additional focus on the actors in the discourse, or with some newly mentioned element. Three classes of constraints on cospecification are needed in the decision.

Syntactic constraints on the choice of focus include gender, number, and person checks of the sort most people learned about in grammar school. These rule out the cospecification of "it," for example, with "my students" because the number and gender are different. In addition there are constraints on the use of reflexives, as in s8 and s9 below, and on disjoint reference, as in s10 and s11. The latter are best presented in the work of Lasnik (1976) and Reinhart (1976) and will not be discussed here; the rules for reflexives still perplex linguists and

no general theory adequately explaining s8 and s9 is available. Hence, the process model makes incorrect choices for some reflexives. In the examples below, underlining indicates cospecification.

s8 The pie has flies on it.
s9 John has a bet on himself/ *him.
s10 Near him, Dan saw a snake.
s11 Near Dan, he saw a snake. (no cospecification possible)

In each of these cases there are syntactic rules recoverable from sentence structure which permit or block certain cospecifications.

Semantic constraints on focus take two forms. One, semantic selectional restrictions, indicates classes of elements which can be associated with the subjects and objects of verbs. For example, the subject of "pick up" must be an entity which can pick things up, such as an animate creature with limbs. The object may be a physical object, but not an entity such as rage or air. Another form of semantic constraint comes from the semantics of Chomsky (1976). In a sentence such as s12 the theory of logical form (Chomsky, 1976) determines that "he" and "the man who . . . " must be disjoint in reference, that is, in the terms of this paper, the two phrases and their interpretations cannot cospecify.

s12 The man whose house he bought in November moved to China.

A third form of constraint is that imposed by common sense knowledge. This constraint eliminates possible cospecifications based on what speakers and hearers know about the world. For example, in D5 below, speakers and hearers know that the dog bit the vet in the hand because vets have hands, while in D6, the vet gave the dog a vaccine because dogs cannot give vaccines.

D5–1 I took my dog to the vet the other day.
    2 He bit him in the hand.
D6–1 I took my dog to the vet the other day.
    2 He gave him a vaccine for heartworm disease

This constraint must be provided by two additional process behaviors: a knowledge base which encodes people's knowledge of the everyday world, and an inference "machine" which can search though the knowledge for reliable inferences and contradictions. Researchers in artificial intelligence have explored both inference machines and knowledge systems over the past several years; relevant research by Charniak (1972), Rieger (1974), Fikes and Hendrix (1977), Smith (1978), and Brachman (1978) offer insights into these processes. The inference machines use general deductive inferences to determine how to infer from one event the existence of another probable event, while the knowledge systems research proposes various systems which encode generic elements, in-

stances of those generics, semantic associations of elements of the database with other elements, notations for scope of quantification, and hierarchical representation of the relation between generic elements.

If the anaphor interpreter rejects the focus as the cospecification of an anaphor due to any one of the syntactic, semantic, or common sense knowledge constraints, the interpreter must choose a cospecification from the newly mentioned elements resulting from the last interpreted sentence. For each choice, the interpreter must apply the constraints from the three classes of information until it finds a choice which is not rejected. If one is found, it is the cospecification, while if none can be found, a condition of non-cospecification can result. This condition accounts for the discourse given below in which the pronoun "their" has no cospecification in the previous discourse.

> D7–1 Football is becoming a very tough sport.
>   2 Their injuries went up 45% last year.

While cases such as D7 almost never occur in written text (presumably due to good editing), they do appear in conversation. The theory presented here does not account for why speakers say such things, but it does predict that hearers behave differently in interpreting the speaker's language use.

The third step in the focus tracking process is focus updating. This process "takes stock" of the anaphoric expressions that were used in the sentence that was just interpreted as these indicate the change in or retention of focus. The processor looks to see what kind of terms were used and determines whether or not the focus had changed since the last sentence was interpreted. In making its decision, the focus updating process considers personal pronouns (such as "it") and demonstrative pronouns (such as "this"), anaphoric definite noun phrases ("the ball" where a blue ball was mentioned), ellipsed noun phrases (such as the event in "John was invited but not Mary"), and the lack of anaphoric expressions.

The focus updating processor bases its decisions about focus tracking on the following preferences among anaphoric expressions. It prefers retaining the current focus whenever a pronoun cospecifies with the current focus. However, several conditions can override this "unmarked" case. Syntactic forms such as there-insertion and clefting, cause the focus updating processor to choose a different focus. The presence of noun phrases containing the article "this" moves the focus immediately to whichever element the phrase specifies. When a new discourse element is cospecified with a pronoun and the focus is not, the focus updating processor moves the discourse focus to the new discourse element. Should no pronoun anaphora occur, the focus updating processor makes its decision based on which of the criteria given below occur first:

1. The current focus is cospecified by some other type of anaphoric expression. Action: retain the focus.

2. The current focus is specified indirectly by a related phrase (such as a generic or semantically associated element). Action: retain the focus.
3. The current focus is ellipsed and fills a non-obligatory case slot in the semantic caseframe of the sentence. Action: retain the focus.
4. Some discourse element is cospecified by an anaphoric (but non-pronominal) expression. Action: move the focus to that element.
5. No elements in the discourse are cospecified. Action: retain the focus.

In all movement cases, the focus updating process keeps the old focus in a special list called a stack. The top list element may be taken one at a time.

To understand how the focus updating processor behaves, let us again return to D1, repeated below as D8, and simulate its processing.

D8-1 Last week there were some nice strawberries in the refrigerator.
2 They came from our food co-op and were unusually fresh.
3 I went to use them for dinner,
4 but someone had eaten them all.
5 Later I discovered it was Mark who had eaten them.
6 He has a hollow leg,
7 and it's impossible to keep food around
8 when his stomach needs filling.

D8-1 sets the focus on the strawberries. D8-2 re-mentions the strawberries with a pronoun. D8-2 also uses the pronoun "our" to mention the speaker (who is the actor focus). The focus updating processor uses these two pronouns to retain strawberries as discourse focus and to set up the speaker as actor focus. D8-3 uses pronouns "I" and "them" to re-mention the speaker and the strawberries. The focus updating process continues its tracking by keeping the discourse and actor foci on strawberries and the speaker. D8-4 introduces another actor "someone" and re-mentions the discourse focus once more using "them". The re-mention of strawberries keeps the discourse focus on strawberries, but the actor focus moves to the new actor. D8-5 presents a case of syntactic construction to mark focus movement. D8-5 is a cleft sentence and the new actor focus is Mark. The reader will note that the old focus of strawberries is also rementioned by the anaphoric expression "them." D8-6 re-mentions the new actor focus with an anaphoric expression. Since the discourse focus is neither ellipsed or re-mentioned by some type of anaphora, the focus updating processor retains the actor focus on Mark and sets the discourse focus on him as well; the old focus of strawberries is placed on the focus stack. D8-7 also does not mention new elements anaphorically, so the focus on Mark is retained until D8-8 where Mark is re-mentioned anaphorically by the use of "his".

Speakers and hearers keep track of more than one focus at a time. In the example about strawberries, as well as in the discourse between A and B about calculators, there are both actor and discourse foci. These examples are both

relatively simple to describe because there are no conflicts between the actor and discourse foci; in none of the cases are pronouns used which might syntactically or semantically cospecify with both. When the speaker has both actor and discourse foci present, s/he is constrained in the choice of an anaphor to refer to each. That is, when a pronoun can cospecify with both, the speaker may not use the pronoun. This case is similar to the constraint on using a pronoun to re-mention a new discourse element in the presence of a focus which can be referred to by that pronoun. Unlike the focus new element case, when an anaphor can cospecify with either the actor or the discourse focus, the hearer cannot choose the discourse focus by default; thus, the ambiguity is less easily resolved. Al-though it is not discussed here, other phrases in English help indicate dual foci, particularly the use of "this" and "that".

The focus updating processor must permit a special behavior as shown in the extension of D8 below.

> D8–9 Since the strawberries were gone forever,
>   10 I didn't make any dessert for dinner
>   11 In the end Mark paid a price for eating them
>   12 because I have planned to use them in strawberry shortcake, his favorite dessert

"The strawberries" returns the discussion to the original focus, so that the focus updating processor must note that the newly mentioned element cospecifies with a member of the focus stack. In doing so, the focus updating processor changes the focus in a special way; it shifts the discussion back to strawberries, rather than moving the discussion forward in the manner described previously. To make the shift, the focus updating processor takes elements off the stack until the element with which "the strawberries" cospecifies is found. This backward movement of focus is a common way of speaking about elements of the dis-course. For some discourses, such as stories, backward movement at the end of a story acts to tie the story together as a whole.

The focus updating processor clarifies why the focus processor as a whole is cyclic in its steps without being circular in definition. Each time a new sentence of the discourse is interpreted, the focus processor analyzes and updates its own current focus of attention. It uses that focus to decide how to interpret the anaphoric expressions in the next sentence, and the interpretation it reaches helps to update the current focus again. The focus processor tells us something about the use of anaphoric expressions, and it is to this explanation we will turn in the next section.

However, first let us consider how to evaluate the focusing process and the algorithm that I have sketched as a means of keeping track of the foci of discourse. Such evaluation is simply a matter of empirical investigation of how well the machinery predicts viable foci for rules of anaphoric interpretation. If

reasonable anaphoric interpretation rules fail, and there is reason to believe the rules are correctly stated, then one can review whether the foci chosen by the focus machinery have made the correct anaphoric interpretation inaccessible. For example, suppose the focus machine predicts that the discourse focus moves from some discourse element x to another element y; if a speaker uses an anaphor which native speakers understand as cospecifying x, but the machinery indicates that x is inaccessible because y has the right syntactic, semantic, and pragmatic "shape," then the machine would be predicting incorrectly on some aspect of the discourse foci. In general, the focusing process gives a detailed account of possible behavior and can be evaluated by empirical study, just as one would hope for a scientific discipline.

4. CONSTRAINING THE USE OF ANAPHORA

The focus processor helps explain the ways in which people are permitted to use anaphoric expressions in English. From observing the processor in action and considering its choices for action, I can state several constraints governing speaker's use of anaphoric expressions. These constraints are determined by:

1. discourse elements from the speaker's own discourse context,
2. syntactic forms in the discourse,
3. presence of several foci,
4. the context of another speaker's discourse.

Generally, a speaker must mention an element in order to use an anaphoric expression to cospecify with it. One exception to this re-mentioning rule is the non-cospecification use shown in D7. In English, non-cospecification cases can be used only marginally. They occur more often than we realize, but the speaker who uses one does so at his/her peril, since it is not always possible for the hearer to recover what is being talked about. Another exception to the re-mentioning rule, forward cospecification, occurs when a subordinate clause contains an anaphor whose cospecification is ahead of it in the main clause, as in

s13 When I caught it, the frog squealed like a pig.

However, this use must not occur when an already existing focus could be re-mentioned with the pronoun "it".

Discourses normally proceed in an orderly progression with the speaker mentioning something, saying something about it, and then moving to some new thing. Of course, many elements will be mentioned only once, and to track the focus, syntactic, semantic, and common sense (often called pragmatic) criteria are needed to decide what is indeed being re-mentioned by the anaphoric expression. Because of these criteria, when a new element is talked about instead of

the current focus, the speaker must use an anaphoric expression which has enough information to distinguish between the two. The focus is the default choice for the cospecification of an anaphoric expression. If both the focus and the new element can be mentioned by an anaphor such as "it," then the other criteria must eliminate the focus as a possible choice. If these cannot, then the speaker should not use "it" to refer to a new element of the discourse as the hearer will take it to mean the current focus. In such cases a fuller anaphoric phrase, such as one that includes the head noun describing the element or a lexical generalization, is needed.

Syntactic sentence forms such as clefting, pseudo-clefting, and there-insertion also mark focus changes and the corresponding changes in the cospecifications of anaphoric expressions. A cleft or pseudo-cleft sentence which marks something besides the current focus as the known portion of the cleft is illegal, and results in bizarre discourse structure. Similarly, a there-insertion sentence which introduces the already current focus is illegal as well; most hearers will understand the sentence as introducing a new element which is different from the current focus. Although it will not be discussed here, it is reasonable to hypothesize that there are marked intonation forms[4] which will perform the same change of focus.

When two speakers interact, there are constraints on how they may use a focus and any anaphoric expression which depends upon the focus. When a speaker wants to talk about something other than what the last speaker spoke about, s/he must introduce the new focus as clearly different from the other speaker's focus. In contrast, a speaker who wants to pick up on what another speaker has said, may use anaphoric expressions just as if s/he had started the discourse. Failure to follow these rules puts a burden on the hearer that may cause him or her to misinterpret the speaker's utterance. A case in point is the use of "the device" in D2–7. B uses the term since calculators have been discussed. However, A ended discussion with the focus on students and problems, so that calculators are not directly present in the discourse, and B cannot pronominalize calculators directly. Suppose B had said "That's all well and good but I think they need more instruction on it to reduce the number of questions." The hearer would have needed to search backwards through the discourse for some element with the acceptable set of syntactic and semantic properties—to the pronoun (which itself cospecifies with calculator) in D2–3. Hearers are clearly capable of this search, but the search is costly in time—time during which the conversation

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[4]For example, the discourse below is unacceptable when read with normal intonation

D9–1 Robby made breakfast for the king last week
2 Robby thought it tasted very good,
3 but he didn't think so,

However, if the speaker uses contrastive stress on the last occurrence of "he," the discourse is entirely understandable

continues. To eliminate this distracting search during the discussion, the speaker is obliged to use the focusing constraints.

Any shift to an old focus, such as the one in the extension to the strawberry discourse, is governed by constraints on anaphora use as well. Normally the shift is accomplished by a full simple definite noun phrase, as exemplified by the use of "the strawberries" in D8, or by lexical generalization as illustrated by "the machine" in the last sentence of D2. However, a pronoun may be used if the action specified in the verb links to an expected action given somewhere in the previous context. The following example from the work of Grosz (Deutsch, 1974) illustrates this behavior. The reader will notice that "I got it loosened" links directly to the expectation of loosening in "I'm trying to . . . get it unstuck." The focus tracking processor described in this paper will not proceed correctly by itself on this kind of example. Rather, the focus tracking processor must be included in a more comprehensive model which can recognize related structures in a speaker's discussion when those structures do not appear in sentences which immediately follow one another. Such a model could use the focus tracking processor to track the focus between the related structures. Sidner (1979) reports a preliminary experiment with such a model, while Robinson (1981) discusses a comprehensive approach based on the interpretation of verb phrases.

> D10–1 A: One of the bolts is stuck and I'm trying to use both the pliers and the wrench to get it unstuck.
> 2 E: Don't use the pliers. Show me what you are doing. Show me the 1/2" combination wrench.
> 3 A: Ok
> 4 E: Show me the 1/2" box wrench.
> 5 A: I already got it loosened.

Lexical generalization indicates only a small part of the role of knowledge representation in the focus tracking process. For any given element a person may think of, such as a book, there are other elements associated with it, such as the title, the cover, the pages, and the author. These can constitute an implicit remention of the focus and therefore affect the behavior of the focus updating process. The use of implicitly associated concepts indicates that the links which exist in some way in a person's memory affect the choice of focus. A complete discussion of knowledge representation demands more treatment than can be given here.

5. RELATED WORK

The research reported in this paper builds on the research of Grosz (1977, 1978, 1981). Grosz uses the concept of focusing as a tool for explaining discourse

structure and disambiguating definite noun phrases. She defines the concept of a focus space, which is a subset of all the knowledge which is relevant to the discourse and encoded in a database. Focus spaces are implemented as a partitioned semantic network representation of objects currently highlighted by the discourse and computed dynamically during the interpretation of a dialogue. Elements that are highlighted are said to be "in focus," that is, the element is represented in a focus space. Grosz observes that several focus spaces can be "open" at one time due to the nature of a discourse, but that only one of the spaces is "active," or currently selected. Focus spaces are open because the discourse has not indicated that discussion of the objects in them has ended.

Those focus spaces not currently selected may be reselected for two reasons: the current focus space may represent a subtask which has ended so that a jump back to an open space is forced; or the current task in the discourse may contain a referent back to an object in an open space and that space will be reselected. In addition to the focus space, there is a plan for the general task which one of the speakers is trying to perform and which the speaker is trying to talk about. The task plan, or task model, is a data structure outlining the subtasks needed to perform each task. This plan is used as part of the focusing mechanism.

Using focus spaces to explain definite noun phrase use, Grosz points out that some objects are implicitly in focus. For example, parts of an object are implicitly in focus when an object is in focus. A major part of her work is devoted to developing a noun phrase resolution procedure which can match noun phrases represented as semantic network fragments containing variables against a semantic network database. The focus space representation is used to constrain the search for a matching piece of the network. Noun phrase resolution done in this way is used to resolve non-pronominal definite noun phrases and to answer questions which arise in discourse.

Grosz is able to account for many of the uses of non-pronominal definite noun phrases by using focus spaces. Such references occur within open focus spaces and refer to objects in the focus spaces. Grosz also distinguishes between a global and an immediate focus. She says that "global focus refers to the influence of memory for the more general meaning conveyed by the preceding utterances of a discourse on the current sentence, while immediate focus refers to the interpretation of a listener's memory for the linguistic form of an utterance" (1977, p. 5). The immediate focus of a sentence is used to expand an elliptical phrase in a subsequent sentence.

cf Halliday distinction between reference and substitution

Grosz' work leaves a number of open problems. Among them are: how a focus can be used for pronoun disambiguation, specification of rules for what makes an immediate focus, and specification of a full set of rules for disambiguation of definite noun phrases. Furthermore, Grosz limits her discussion of focus movement to movement reflected in the structure of a task. In Grosz' work, focus moves when a new part of a task is started or when a task part is completed. This paper explores how immediate foci affect focusing, and illustrates how a

focus moves when there is less well specified information shared between the speaker and hearer than that which is represented in the task model data structure of Grosz. Expanding on Grosz' work in this manner, one can conclude that when speakers and hearers share less explicit information about the structure of the speaker's memory, the speaker must use the kinds of discourse syntactic cues of which the focus tracking processor takes advantage to inform the hearer of the structure of the conversation.

Several other researchers have pursued work on interpreting discourse structures. A few examples of research representative of this area will illustrate how focusing is relevant to this work. Hobbs (1979) has introduced the concept of coherence relations. These relations specify more about what makes a discourse a coherent whole though a taxonomy of the relations which can occur among sentences of a discourse. Hobbs defines coherence relations over the propositions encoded in sentences; he chooses the relations "elaboration, parallel" and "contrast". He uses these to predict what he calls the coreference relations between pronouns and their antecedents. Like much of the research on discourse structures, disambiguation of the antecedents of pronouns is a by-product of other processes of comprehension; it happens during the computation of the coherence relations.

This account seems to argue against a focusing approach, but focusing can be viewed as an extensive explanation of the processing behind one of the coherence relations. In the short discourse below, focusing predicts the cospecification of "he" to Roger in D11-2 and 11-3 by establishing Roger as the initial focus. In Hobbs' theory, D11-2 would probably be taken as an elaboration of D11-1, since elaboration between two clauses A and B is defined as the proposition in B that follows from the proposition of A.

> D11-1 Roger hasn't been at work all week.
> 2 Marty thinks he went hunting.
> 3 but more likely, he is playing in one of those week long poker
> tournaments.

However, if Hobbs' definition of elaboration is applied to the example, the sense in which the proposition of 11-2 follows from the proposition of D11-1 is exactly what the focus relation captures, that is, that 11-2 and 11-3 are about Roger and what he is doing.

Two other researchers have sought to define structures for stories in particular using either a bottom up parsing of the story to a given structure (Schank & The Yale A.I. Project, 1975), or a top down to a context free grammar (Rumelhart, 1975). The Schank model uses a script which describes a mundane event. Sentences of a story are matched against the units of the script. The Schank model is similar to the Grosz task model although a script has less structure and therefore needs a close match of sentence to script unit to make any predictions about

discourse. Furthermore, the script model does not extend to less mundane situations. The Rumelhart story grammar uses general rules and predicates to relate the sentences of a story. For example, a story has settings and episodes and episodes are events and reactions. Any sentence which can be seen as either an event or reaction is, thus, an episode. The generality of this model suggests that it could be applied widely to many stories, but Rumelhart does not specify enough of the semantics of the predicates such as event and reaction to explain how anaphoric references are used by the speaker.

The definition of focus used in this work comes from the notion of immediate focus as defined by Grosz. It is related to concepts of focus and topic as these terms are used by Lyons (1968), Sgall, Hajicova, and Benesova (1973), Grimes (1975), Halliday (1967), Kuno (1975), Chafe (1976), and Chomsky (1971). All these researchers discuss focus in descriptive ways, but they have little to say about it as a process behavior.

For Sgall and Lyons, topic is defined as what is talked about in a sentence, while comment is what is said about the topic. Halliday and Kuno use the terms theme and rheme in a similar way. For these researchers, the definition of topic appears to be considered for single sentences only. Variations on these terms include Grimes' use of theme as a signaling device for cohesive structure given a speaker's view; to be precise, the theme is the semantic choice to the point of departure of a sentence. Chafe, by contrast, claims that the topic-theme distinction is just the way a phrase in discourse is distinguished from other shared background knowledge. He calls this topic-theme definition by the name of "focus of contrast" while reserving "topic" for the behavior which illuminates the frame from within which a sentence holds, particularly for languages like Chinese which he claims are topic prominent.

Halliday and Chomsky each define a focus grounded in phonology. For Halliday, the focus, a part of the information dimension of structuring communication, is realized by phonological prominence; it is closely related to primary stress. The information focus is a discourse feature which reflects where the main burden of the message lies; the focus lies within an information unit and relates that unit to the previous discourse by assigning the unit a particular structure. The structure indicates which of its elements are "given" and "new," by which Halliday means whether or not the status of being derivable from the discourse is assigned by the speaker. The given and new labels, Halliday claims, represent the speaker's interpretation of the relation of what is being said to the preceding discourse.

The focus concept of Halliday and the one defined in this paper as discourse focus bear similarity, although discourse focus is not defined solely in terms of phonology.[5] Discourse focus, like information focus, indicates where the main

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[5] Although phonological means of marking focus is mentioned, the research reported here does not build on that basis largely because interpretation of phonological constraints from discourse information is too little understood computationally to be relied upon

burden of the message lies since it is the element of main attention to the speaker. The focus tracking process illustrates how a speaker introduces new information (in Halliday's sense) and then carries it forward as an element to which other information is related until another element, newly introduced, in turn becomes the focus. While Halliday's account of information focus is descriptive, the focus tracking process and discourse focus are a computational account of one of the ways speakers structure communication over several clauses in a discourse.

Chomsky (1971) speaks briefly of "focus" and "presupposition". Focus is the word, under normal intonation, with main stress which serves as the point of maximal inflection of the pitch contour.Thus, in "Is it John who writes poetry?" John is the focus, while the presupposition is that someone writes poetry. He goes on to say that the choice of focus determines the relation of the utterance to the response and to other sentences in the discourse. Akmajian (1973), building on Chomsky's use of focus, indicates that focus can be used to explain the "it" in s14 and s15.

> s14 Pratt roasted a pig in the fireplace last year, but none of his friends realized it.
> s15 Pratt roasted a pig in the fireplace last year and Whitney did it too.

In s15, the focus on Pratt leaves the verb phrase as presupposed, so "did it" is anaphoric to the verb phrase. Here it is not the focus which is the antecedent of the anaphor, but the presupposition. Similarly in s14, the focus is empty, so there is no presupposition, and the whole clause is presupposed by "it". The class of sentence pairs Chomsky and Akmajian consider is limited. This paper offers an alternative account to their model, one which extends the use of focus to other sentence uses.

6. FOCUSING AND RELEVANT CONVERSATION

The focus tracking process and the constraints on anaphoric expressions tell us nothing about what legitimate new discourse "topics" are and how topics are related to focus. That is, focus tracking says nothing about what English speakers intuitively call the topic of a discussion or a paragraph or about what topics are legitimate in a given discourse. For example, most English readers would intuitively say that the topic of D2 is how to teach students about using a calculator. Since the foci of D2 include calculator and students, the meaning of focus discussed here is in some sense related to topic, but the two are not equivalent; topic, if it can be defined successfully, seems to suggest something in addition to focus and focus tracking. Furthermore, since the two are different, it is not surprising that focus tracking indicates nothing about why certain discourses are odd. In the extension of D2 below, C's contribution to the discourse is odd.

> D2-11 C: Well, I think you are both wrong.
>   12 Here's why.

13 I'm going on a vacation to Tahiti tomorrow.
14 I'm going by plane,
15 and I'll be there about a week.
16 It is going to cost me a bundle of money.

C has introduced a new focus and said something about it and its location. contribution is not hard to understand as all the anaphoric expressions are eas interpret. Furthermore, C's comments are connected, as they relate the matte C's vacation. Instead one would complain that C's topic is irrelevant to A B's. Thus, while loss of focus totally disrupts the function of a discourse, o mechanisms also affect its flow. How such topic behavior is determined to irrelevant cannot be stated within the focus tracking theory.

Some preliminary work on topics in discourse is underway. Reichman (19 speaks of a topic as the relationship between utterances which is equivalent to one between the title of a text and the passage the title applies to. She u notion of topic to define rules governing topic shifts; her work suggests that extension above is inappropriate because the speaker is shifting the total topic discussion at a point in which the other current topic has not been exhauste

In recent work by Schank (1977), a topic in a conversation is defined as a object, person, location, action, state, or time that is mentioned in the sentence be responded to. Schank's definition of topic is similar to the definition of foc given here since objects, persons, and the like may be focused on. Its behavi differs because topic is modelled in terms of legal responses by a hearer to spoken sentence. The rules Schank proposes depend on the speaker havi knowledge of the "conversational/associational" categories, that is, concep associated by function, results, price, enable, owner, user, availability, a problem relations with a given object. These categories indicate which associ tions make reasonable responses. However, they do not seem to be able account for the oddity of C's response since C starts the discussion with legitimate lead-in. Furthermore, Schank's rules do not address the proble how a speaker connects his/her utterances once a topic is chosen.

So far, focus has been shown to be an integral component of discourse because it is a means of indicating connectedness in the discourse. From th notion of focus, a processor has been described which tracks focus. This pro cessor allows for a description and explanation of how focus constrains th interpretation and use of anaphoric expressions. It has been shown that focusin does not determine what is relevant to a conversation. However, it can be show that it plays a role in relevance.

In his well known William James lectures, Grice (1975) defined severa maxims of conversation, one of which was the maxim of relevance. Grice say about this maxim:

Under the category of "Relation" I place a single maxim, namely, "Be relevant." Though the maxim itself is terse, its formulation conceals a

number of problems which exercise me a good deal; questions about what different kinds and foci of relevance there may be, how these shift in the course or a talk exchange, how to allow for the fact that subjects of conversation are legitimately changed, and so on. (p. 67)

As long as relevance is a part of a theory of pragmatics, focusing must be included in that theory, whether it is the theory which Grice has begun to unfold or another one. Focusing and focus as they have been used in this paper bear directly on Grice's concerns for they suggest a means for carrying out the maxim of relevance. Namely, a speaker is speaking relevantly in a discourse if he or she introduces a focus, and proceeds to another one by mentioning it and re-mentioning it with definite anaphora. Old foci are reinvoked by a definite noun phrase which points out which old focus is cospecified, or by one of the other, less direct, ways discussed in a previous section. Focus, then, is a necessary condition for relevance for at the moment the speaker fails to provide a focus for the hearer and to point back to it in successive utterances, the hearer has no means of knowing what is or might be relevant in the discourse at hand. Focus is the building block on which topics are constructed; without focusing, the discourse ceases to be a discourse.

Perhaps it is surprising that focusing should play such a basic role in a theory of pragmatics. In particular, it is surprising that focusing one's attention on something and signalling one's focus is part of the criteria for speaking relevantly. One expects relevance to be a matter of what is said about something, rather than that the thing is mentioned consistently. But if we remember that focusing allows the speaker to tell the hearer that the same thing is still under discussion without needing to say explicitly what that thing is, then the role of focusing is not so surprising. Hence, focusing must be the first criterion for speaking relevantly, since it explains how a hearer decides what the speaker is talking about.

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